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Claims

I claim:

- 1 1. An emitter controlled thyristor device having a cathode terminal and an
 2 anode terminal, comprising:
 3 a thyristor device having a thyristor emitter, a thyristor collector, and
 4 a thyristor gate, said thyristor comprising alternating P-type and N-type
 5 semiconductor regions;
 6 a first metal oxide semiconductor transistor (MOS) connected in
 7 series with said thyristor between said cathode terminal said thyristor
 8 emitter, said first MOS transistor integrated in at least one of the
 9 semiconductor regions of said thyristor; and
 10 a second MOS transistor integrated in at least one of said
 11 semiconductor regions connected between said cathode terminal and said
 12 thyristor gate, a gate terminal of said second MOS transistor connected to
 13 said cathode terminal,
 14 wherein a first voltage applied to a gate terminal of said first MOS
 15 transistor causes a forward current to flow between said cathode terminal and
 16 said anode terminal turning said emitter controlled thyristor device to an on
 17 state, and a zero to second voltage [turns] applied to said gate of said first
 18 MOS transistor turns said emitter controlled thyristor device to an off state.

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2. [An emitter controlled thyristor device] as recited in claim 1 further
 comprises a floating ohmic contact (FOC) for shorting said emitter and a
 source terminal of said first MOS transistor.

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3. [An emitter controlled thyristor device] as recited in claim 1 further
 comprises a metal strap for shorting said thyristor emitter and a source
 terminal of said first MOS transistor.

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4. [An emitter controlled thyristor device] as recited in claim 1, further

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figs. 1A, 1B

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fig. 10 1

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comprising:

a third MOS transistor having a source and a drain connected between ^{said} thyristor emitter and a thyristor lower base region, and a gate connected to said cathode terminal.

5. [An emitter controlled thyristor device] as recited in claim 1 wherein said first MOS transistor comprises a PMOS transistor, and said second MOS transistor comprises a PMOS transistor.

6. [An emitter controlled thyristor device] as recited in claim 4 wherein said first MOS transistor comprises a PMOS transistor, said second MOS transistor comprises a PMOS transistor, and said third MOS transistor comprises an NMOS transistor.

7. [An emitter controlled thyristor device] as recited in claim 4 wherein said first MOS transistor comprises a NMOS transistor, said second MOS transistor comprises a PMOS transistor, and said third MOS transistor comprises an NMOS transistor.

8. [An emitter controlled thyristor device] as recited in claim 4 further comprising a metal strap for shorting said thyristor emitter with one of a drain and source terminal of said first MOS transistor.

9. [An emitter controlled thyristor device] as recited in claim 1, further comprising a diode connected between said gate of said first MOS ^{transistor} and said thyristor emitter.

10. An emitter turn-off thyristor (ETO) device for carrying current between a cathode terminal and an anode terminal, comprising:
a thyristor having a thyristor emitter, a thyristor collector connected to said anode terminal, and a thyristor gate; and

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fig. 10
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fig. 4B
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fig. 2B
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figs. 9A, 9B

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5 a packaged metal oxide semiconductor (MOS) transistor connected
6 between said thyristor emitter and said cathode terminal, wherein said
7 thyristor is turned on to conduct current between said cathode and said anode
8 terminal by applying a first voltage to a gate of said MOS transistor and
9 turned off by applying a second voltage to said gate of said MOS transistor.

1 11. An emitter turn-off thyristor (ETO) device as recited in claim 10 further
2 comprising:

3 a diode connected between said thyristor gate and said cathode
4 terminal, wherein a threshold voltage of the diode is higher than a voltage
5 drop across the thyristor gate to cathode plus a voltage drop across said MOS
6 transistor in an on-state.

1 12. An emitter turn-off thyristor (ETO) device as recited in claim 11, further
2 comprising:

3 a charge storage device connected in parallel with said diode, said
4 charge storage device providing a turn-on current for said thyristor gate.

1 13. An emitter turn-off thyristor (ETO) device as recited in claim 12
2 wherein said diode comprises at least one Zener diode.

1 14. An emitter turn-off thyristor (ETO) device for carrying current between
2 a cathode terminal and an anode terminal, comprising:

3 a thyristor having a thyristor emitter, a thyristor collector connected
4 to said anode terminal, and a thyristor gate;

5 a first metal oxide semiconductor (MOS) transistor connected
6 between said thyristor emitter and said cathode terminal;

7 a charge storage device connected between said thyristor gate and
8 said cathode terminal; and

9 a second MOS transistor connected in parallel with said charge
10 storage device, wherein said thyristor is turned on to conduct current

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figs. 13A, 13B

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11 between said cathode and said anode terminal by applying a first voltage to a
12 gate of said first MOS transistor and turned off by applying a second voltage
13 to said gate of said first MOS transistor.

1 15. An emitter turn-off thyristor (ETO) device as recited in claim 14
2 wherein said second MOS transistor is a PMOS transistor having its gate
3 terminal and drain terminal connected together to said cathode terminal.

1 16. An emitter turn-off thyristor (ETO) device as recited in claim 14
2 wherein said second MOS transistor is a NMOS transistor having its gate
3 terminal and source terminal connected together.

1 17. An emitter turn-off thyristor (ETO) device package comprising:
2 a first die comprising a gate-turn off thyristor (GTO), said first die
3 having an anode terminal, a thyristor gate, and at least one emitter finger;
4 and
5 at least one second die comprising a metal oxide semiconductor
6 (MOS) transistor connected in series with said first die, a first terminal of
7 said MOS transistor contacting at least one said emitter finger, and a second
8 terminal of said MOS transistor acting as a cathode terminal,
9 wherein a first voltage to a gate of said MOS transistor turns said
10 thyristor on passing current between said cathode terminal and said anode
11 terminal, and a second voltage to a gate of said MOS transistor turns said
12 thyristor off.

1 18. An emitter turn-off thyristor (ETO) device package as recited in claim
2 17, further comprising:
3 a plurality of said emitter fingers on a surface of said first die;
4 a plurality of said second die, each comprising a MOS transistor
5 connected in series with said first die on one of said plurality of emitter
6 fingers; and

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figs. 15A, 15B

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7 a metal strip sandwiched between each of said plurality of emitter
8 fingers and each of said plurality of second die.

1 19. An gate turn-off (GTO) thyristor device package comprising:
2 a first metal plate;
3 a second metal plate;
4 a third metal plate electrically insulated from said second metal layer;
5 a thyristor sandwiched between said first metal plate and said second
6 metal plate, a collector of said thyristor contacting said first metal plate
7 acting as an anode for [said ETO device package];

8 a first metal oxide semiconductor (MOS) transistor positioned on said
9 second metal plate adjacent said thyristor, said first MOS transistor having a
10 first terminal connected to an emitter of said thyristor and [a second terminal
11 connected to said third metal plate acting as a cathode for [said ETO device
12 package]; and

13 a second MOS transistor positioned on said second metal plate
14 adjacent said thyristor, said second MOS transistor having a first terminal
15 connected to a gate of said thyristor, said second MOS transistor further
16 having [a second terminal and a gate terminal connected to said third metal
17 plate],

18 wherein a first voltage applied to a gate terminal of said first MOS
19 transistor turns said thyristor to an on state causing a current to flow between
20 said cathode and said anode, and a zero to second voltage applied to said
21 gate of said first MOS transistor turns said emitter controlled thyristor device
22 to an off state.

1 20. An gate turn-off (GTO) thyristor device package as recited in claim 19,
2 further comprising a clamp means for holding said first, second and third
3 metal layers together.

1 21. An gate turn-off (GTO) thyristor device package as recited in claim 19

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figs. 17A, 17B

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2 wherein said first, second, and third metal plates comprise copper plates.

1 22. An gate turn-off (GTO) thyristor device package as recited in claim 19
2 wherein said first MOS transistor and said second MOS transistor are
3 complementary.

1 23. An gate turn-off thyristor (GTO) device package comprising:
2 a gate turn-off (GTO) thyristor comprising a thyristor gate, a
3 thyristor emitter, and a thyristor collector forming an anode terminal;
4 a plurality of MOS transistors connected in parallel arranged in a
5 circular fashion around said GTO thyristor, a first terminal of said MOS
6 transistors connected to said thyristor emitter and [a second terminal of said
7 MOS transistors connected to a cathode terminal of said GTO device
8 package]; and
9 a plurality of MOS switching devices connected in parallel arranged
10 in a circular fashion around said GTO thyristor, a first terminal of said MOS
11 switching devices connected to said thyristor gate and [a second terminal of
12 said MOS switching devices connected to said cathode terminal of said GTO
13 device package].
14 wherein a first voltage applied to a gate terminal of said MOS
15 transistors turns said GTO thyristor to an on state causing a current to flow
16 between said cathode terminal and said anode terminal, and a zero to second
17 voltage applied to said gate of said MOS transistors turns said GTO thyristor
18 to an off state.

1 24. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 further comprising:
3 a first metal plate forming said cathode terminal;
4 a second metal plate separated from said first metal plate by an
5 insulation layer, wherein said GTO thyristor and said MOS transistors and
6 said MOS switching devices are positioned on said second metal plate, said

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B6fig. 17A-17C
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7 first and second metal plates acting a heat sink.

1 25. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 further comprising a third metal plate on top of said GTO thyristor forming
3 said anode terminal.

1 26. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 wherein said MOS switching devices comprise a MOSFET transistor having
3 a gate connected to said cathode terminal.

1 27. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 wherein said MOS switching devices comprise a diode.

1 28. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 wherein said MOS switching devices comprise a diode connected in parallel
3 with a capacitor.

1 29. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 wherein said MOS switching devices comprise a Zener diode connected in
3 parallel with a capacitor.

1 30. An gate turn-off thyristor (GTO) device package as recited in claim 23
2 wherein said MOS switching devices comprise a transistor connected in
3 parallel with a capacitor.

1 31. An gate turn-off thyristor (GTO) device package as recited in claim 26
2 further comprising;

3 [a first feedback path connecting said gate terminal of said MOS
4 transistors to said thyristor emitter]; and

5 a second feedback path connecting said gate terminal of said MOS
6 transistors to said thyristor gate terminal through a diode.

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fig. 17B

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fig. 19

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fig. 18

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32. A gate turn-off thyristor (GTO) device package as recited in claim 23 further wherein [said MOS switching device] comprises a MOS transistor comprising;

a feedback path connecting said gate terminal of said MOS transistors to said thyristor emitter;

a capacitor connected in parallel to [said second feedback path] connecting said gate terminal of said MOS transistors to said thyristor gate terminal through a diode.

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